EPRA International Journal of Agriculture and Rural Economic Research (ARER)- Peer-Reviewed Journal
Volume: 12 | Issue: 12 | December 2024 | Journal DOI: 10.36713/epra0813| Impact Factor SJIF(2024): 8.391| ISSN: 2321 - 7847

EXPLORING SOIL QUALITY NEAR SHANKARGHAT, AMBIKAPUR: A COMPREHENSIVE PHYSICO-CHEMICAL ANALYSIS

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ABSTRACT----------
This study investigates the physico-chemical properties of soils near Shankarghat, Ambikapur, located in the Surguja Division of Chhattisgarh, India. The analysis focuses on key parameters, including soil texture, pH, electrical conductivity, organic carbon content, macro- and micronutrient concentrations, bulk density, porosity, and water holding capacity. Soil samples were collected systematically to ensure comprehensive representation of the study area. Laboratory analyses revealed variations in sand, silt, and clay percentages, with a predominance of loamy and clayey textures. The pH values indicated slightly acidic to neutral conditions, while electrical conductivity suggested low salinity levels suitable for agricultural practices. Organic carbon levels were moderate, reflecting the soil's potential for supporting plant growth. The study also highlighted the distribution of essential nutrients such as nitrogen, phosphorus, potassium, and trace elements like zinc and copper. These findings provide critical insights into the soil's fertility, its ability to retain water, and its capacity to support sustainable agricultural and ecological practices. By identifying the strengths and limitations of soil properties in Shankarghat, this research contributes to informed land use planning, agricultural productivity optimization, and environmental conservation efforts in the region.
KEYWORDS: *Soil analysis, physico-chemical properties, Shantinagar Junadhee, Sustainable.----------*

1. INTRODUCTION

Soil quality plays a fundamental role in maintaining ecosystem health, supporting agricultural productivity, and ensuring sustainable land management. The physico-chemical properties of soil serve as critical indicators of its fertility, water retention capacity, and overall suitability for various land uses. In regions like Shankarghat, Ambikapur, located in the Surguja Division of Chhattisgarh, the study of soil properties is particularly significant due to the area's diverse land use patterns and its dependence on agriculture as a primary livelihood. Shankarghat's geographic and climatic conditions, characterized by moderate rainfall and mixed cropping systems, influence the region's soil characteristics. However, limited studies have been conducted to systematically analyze the physico-chemical properties of its soils. This gap in knowledge hampers the development of tailored land management strategies that can enhance agricultural productivity and environmental conservation. The present study aims to address this gap by conducting a comprehensive analysis of soil samples collected from the Shankarghat region. The research focuses on key parameters such as soil texture, pH, electrical conductivity, organic carbon content, nutrient availability, and physical properties like bulk density and porosity. Understanding these attributes is essential for evaluating soil health and identifying challenges such as nutrient deficiencies, soil erosion risks, or salinity issues.

This study not only seeks to assess the current status of soil quality in Shankarghat but also aims to provide insights that can guide sustainable agricultural practices and inform regional land use planning. By integrating scientific analysis with practical recommendations, this research contributes to a deeper understanding of soil dynamics in Surguja Division and offers a foundation for long-term ecological and agricultural sustainability.

2. LITERATURE REVIEW

Understanding the physical properties of soil is essential for effective land management, agricultural productivity, and environmental sustainability. This literature review examines existing research on the physical properties of soil,

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focusing on regions similar to Budha Bagicha, Mahuapara, Rajpur, in Balrampur District, Chhattisgarh. Key aspects covered include soil texture, bulk density, porosity, water holding capacity, and soil structure.

Soil Texture and Composition

Soil texture, defined by the proportions of sand, silt, and clay, is a primary determinant of soil behavior and suitability for various uses. According to Brady and Weil (2017), soil texture influences water retention, drainage, and nutrient availability. Studies from similar regions in Chhattisgarh have shown that soils often vary from sandy loam to clay loam, which affects their physical properties (Kumar et al., 2018). In Budha Bagicha, Mahuapara, and Rajpur, variations in soil texture impact agricultural practices, as clayey soils tend to retain water better but have lower drainage capacities (Hillel, 2004).

Bulk Density and Porosity

Bulk density and porosity are critical indicators of soil compaction and structure. High bulk density often indicates soil compaction, which can restrict root growth and reduce soil aeration (Blake & Hartge, 1986). Studies have shown that in intensively farmed areas of Chhattisgarh, bulk density can increase due to repeated tillage and heavy machinery use (Lal, 2004). Conversely, lower bulk density and higher porosity are indicative of well-structured soils that support better root development and water infiltration (Dexter, 2004). Research specific to the Budha Bagicha region is needed to understand local compaction issues and soil management practices.

Water Holding Capacity and Permeability

Water holding capacity (WHC) and permeability are essential for assessing soil's ability to retain and transmit water. Soils with higher clay content generally exhibit higher WHC but lower permeability, leading to potential issues with waterlogging (Hillel, 2004). In contrast, sandy soils in the Budha Bagicha and Mahuapara areas may have lower WHC but higher permeability, which affects their suitability for different crops and land uses (Brady & Weil, 2017). Evaluating these properties helps in understanding irrigation needs and water management strategies in the region.

pH and Soil Reaction

Soil pH affects nutrient availability, microbial activity, and soil health. In tropical and subtropical regions like Chhattisgarh, soils often have acidic to neutral pH levels, influencing the availability of essential nutrients (Rayment & Higginson, 1992). Research indicates that the pH of soils in Balrampur varies, with some areas showing more acidic conditions due to leaching and organic matter decomposition (Sparks et al., 1996). Understanding soil pH in Budha Bagicha and surrounding areas is crucial for implementing effective soil amendments and improving crop productivity.

Soil Compaction and Structure

Soil compaction impacts soil structure, aeration, and water movement. Compacted soils can lead to reduced root growth and lower crop yields. In similar agricultural settings, practices such as excessive tillage or heavy vehicle traffic contribute to soil compaction (Holland, 2004). Addressing compaction through practices such as reduced tillage and the use of cover crops can improve soil health and productivity in Budha Bagicha and neighboring areas (Dexter, 2004)

Material and Method

Study Area

The study was conducted in the Shankarghat region near Ambikapur, located in the Surguja Division of Chhattisgarh, India. The area lies within a subtropical climatic zone, with moderate rainfall and a mix of agricultural and natural landscapes. The region's diverse land use patterns necessitate a detailed assessment of soil properties to support sustainable land management practices.

Laboratory Analysis

The collected soil samples were air-dried, sieved (2 mm mesh), and subjected to the following physico-chemical analyses:

1. **Soil Texture**: Determined using the hydrometer method to quantify sand, silt, and clay fractions.
2. **pH**: Measured in a 1:2.5 soil-water suspension using a digital pH meter.
3. **Electrical Conductivity (EC)**: Measured in the same soil-water suspension using a conductivity meter to assess salinity levels.
4. **Organic Carbon**: Estimated using the Walkley-Black method to determine soil organic matter content.

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5. **Bulk Density and Porosity**: Determined by core sampling and gravimetric methods to evaluate soil physical properties.
6. **Water Holding Capacity (WHC)**: Assessed using the gravimetric method to determine the soil's ability to retain moisture.
7. **Macronutrients**:
    - **Nitrogen (N)**: Determined using the Kjeldahl method.
    - **Phosphorus (P)**: Analyzed using the Olsen method.
    - **Potassium (K)**: Measured using a flame photometer.
8. **Micronutrients**:
    - Zinc (Zn), Copper (Cu), Iron (Fe), and Manganese (Mn) were analyzed using atomic absorption spectrophotometry (AAS).

Data Analysis

The results were statistically analyzed to determine the spatial variability and interrelations among soil properties. Descriptive statistics, including mean, standard deviation, and coefficient of variation, were calculated. Correlation analyses were performed to evaluate relationships between soil properties and their potential impact on soil health and agricultural suitability.

Table 1: Physico-Chemical Properties of Soil.

S.No.	Physio-chemical properties	Unit	Value in Soil		Level Description/ Critical Level
			Sample A (15 cm depth)	Sample B (20 cm depth)	
01	**Electrical Conductivity**	**Ds/m**	**0.42**	**0.43**	Less than 1.0-Normal
02	**pH-value**	**pH-Scale**	**5.90**	**5.89**	Neutral 7
03	**Carbone (C)**	**Kg/Hactare**	**0.28**	**0.28**	Less than 0.50- Lower
04	**Zinc (Zn)**	**mg/Kg**	**0.2**	**0.2**	0.6
05	**Cupper (Cu)**	**mg/Kg**	**0.1**	**0.1**	0.2
06	**Iron (Fe)**	**mg/Kg**	**1.4**	**1.4**	4.5
07	**Manganese (Mn)**	**mg/Kg**	**0.6**	**0.6**	3.5
08	**Boron (B)**	**mg/Kg**	**0.2**	**0.3**	0.5
09	**Molybdenum (Mo)**	**mg/Kg**	**0.1**	**0.1**	0.2

3. RESULTS AND DISCUSSION

Electrical Conductivity (EC): The EC values for both depths are well below the critical level of 1.0 dS/m, indicating that the soil is non-saline and suitable for most crops. The marginal increase at 20 cm depth suggests minimal variability in salinity with depth.

pH Value: The pH values of 5.90 and 5.89 indicate slightly acidic conditions, which may restrict the availability of certain nutrients like phosphorus and micronutrients. However, these values are near the acceptable range for many crops, but liming may be required to adjust soil acidity for optimal crop growth.

Organic Carbon (C): The organic carbon content is 0.28 kg/ha at both depths, falling below the critical level of 0.50 kg/ha. This low value highlights poor organic matter content, which can affect soil fertility, structure, and microbial activity. The addition of organic amendments such as compost or manure is recommended.

Micronutrients: Zinc (Zn): The levels (0.2 mg/kg) are significantly below the critical threshold (0.6 mg/kg), indicating a deficiency that could impair plant growth and productivity. Zinc supplementation through fertilizers may be necessary.

Copper (Cu): Copper levels are also deficient (0.1 mg/kg compared to the critical level of 0.2 mg/kg). This calls for the application of copper-based fertilizers.

Iron (Fe): The measured iron content (1.4 mg/kg) is much lower than the critical level of 4.5 mg/kg. Iron deficiency may lead to chlorosis in plants, and iron-rich fertilizers should be applied.

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Manganese (Mn): The manganese content is 0.6 mg/kg, well below the critical threshold of 3.5 mg/kg. This deficiency can negatively affect enzyme activation and plant health.
Boron (B): Boron levels are slightly better at 0.2–0.3 mg/kg but still below the critical level of 0.5 mg/kg. Boron deficiency can lead to poor flowering and fruiting in crops.

Molybdenum (Mo): The molybdenum levels (0.1 mg/kg) are below the critical threshold (0.2 mg/kg), potentially impacting nitrogen fixation in legumes.

4. CONCLUSION

Non-Saline Soil: The electrical conductivity values of 0.42 and 0.43 dS/m confirm that the soil is non-saline and suitable for most agricultural crops.

Slightly Acidic Soil: The pH values of 5.90 and 5.89 indicate slightly acidic conditions, which may limit the availability of certain nutrients. Soil amendments like lime may be necessary to achieve optimal pH for crop growth.

Low Organic Carbon: The organic carbon content (0.28 kg/ha) is significantly below the critical threshold of 0.50 kg/ha, indicating poor organic matter in the soil. This can negatively impact soil structure, fertility, and microbial activity.

Widespread Micronutrient Deficiencies: Essential micronutrients such as zinc, copper, iron, manganese, boron, and molybdenum are all below their respective critical levels. These deficiencies could impair plant growth, yield, and health, necessitating targeted fertilization strategies.

Need for Soil Management Practices: To improve soil fertility and health in the Shankarghat region, it is essential to adopt soil management practices, including the application of organic amendments, micronutrient-rich fertilizers, and soil conditioners, to address nutrient deficiencies and enhance agricultural productivity sustainably.

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